Eurodelta-Trends

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Observed air pollution trends in the EMEP region between 1990 and 2012

Trend assessment

- CLRTAP/EMEP Task Force on Measurement and Modelling
- http://www.nilu.no/projects/ccc/reports/cccr1-2016.pdf

Ozone

- Flat trend for annual mean (1990-2012)
- 10% reduction in the amplitude of peaks (1990-2012)
- 20% reduction in the number of 50ppb exceedances (1990-2012)
- 30% and 37% reduction of SOMO35 and AOT40 (2002-2012)

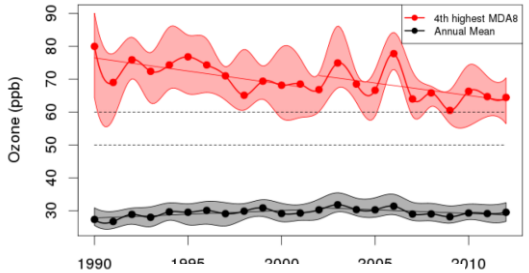
Sulphur & Nitrogen compounds:

- 60 to 90% reduction for S (1990-2012)
- 30 to 40% reduction for N (1990-2012)
- 30% reductions of PM10 & PM2.5 (1990-2012)
- Flattening of the trend for reduced N over past 10 yrs

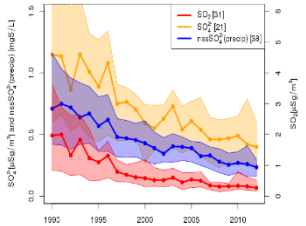
HM&POP

- 60 to 80% reductions for Pb, Cd, HCB
- 30% for Hg & BaP (flat trend over recent years)

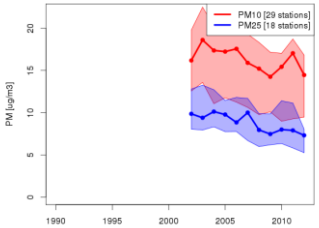
O3

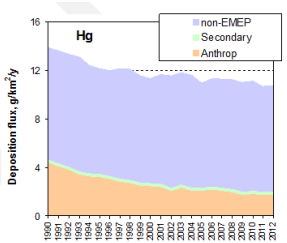


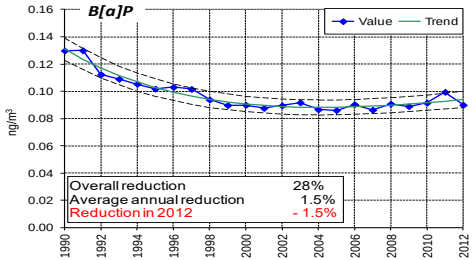
Ox. S



PM







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Multi-Model hindcast of Air Pollution in Europe for 1990-2010

Science & Policy Questions

Model validation	How do models compare with observations in 1990, 2000, 2010 ? How do models capture the trend in observations (1990-2010)?
Attribution	Can we detect a significant impact of emission changes in Europe ? Can we detect a significant impact of emission changes beyond Europe ? Does meteorological variability affects the AQ trend over the past 20 yrs?
Impacts	Provide input to health & ecosystems impact models

Experimental setup

Description of the exercise

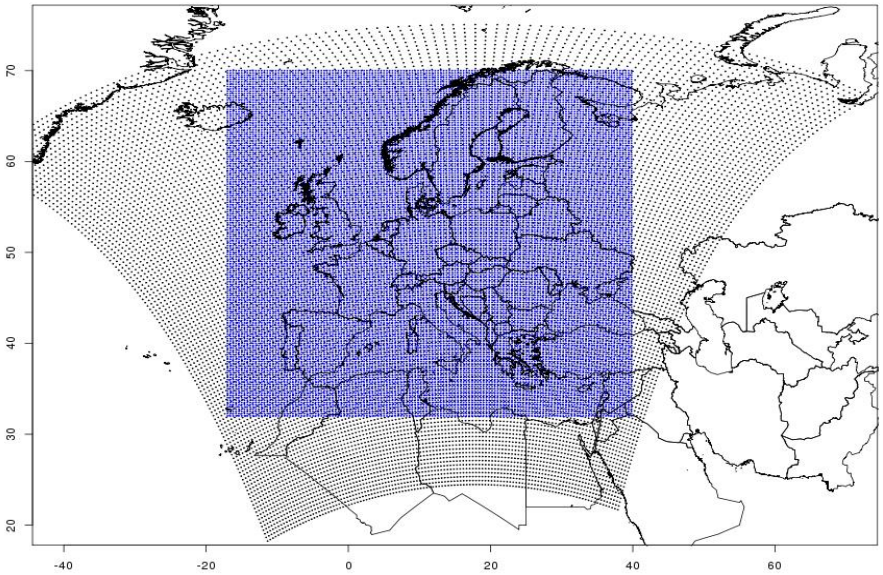
- GMD 2017 model experiment description paper

8 regional CTMs

- Chimere (INERIS+CIEMAT, FR+ES)
- CMAQ (BSC,ES)
- EMEP (MSC-W, Met-Norway)
- LOTOS-EUROS (TNO, NL)
- MATCH (SHMI, SE)
- MINNI (ENEA, IT)
- Polair3D (CEREA, FR)
- WRF-Chem (IASS, DE)

Common setup

- Domain ~25km resolution
- Meteorology (WRF/EuroCordex, some exceptions)
- Emissions (GAINS/ECLIPSE-V5)
- Boundary conditions (Obs-based)



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Experimental setup

3 tiers of experiments

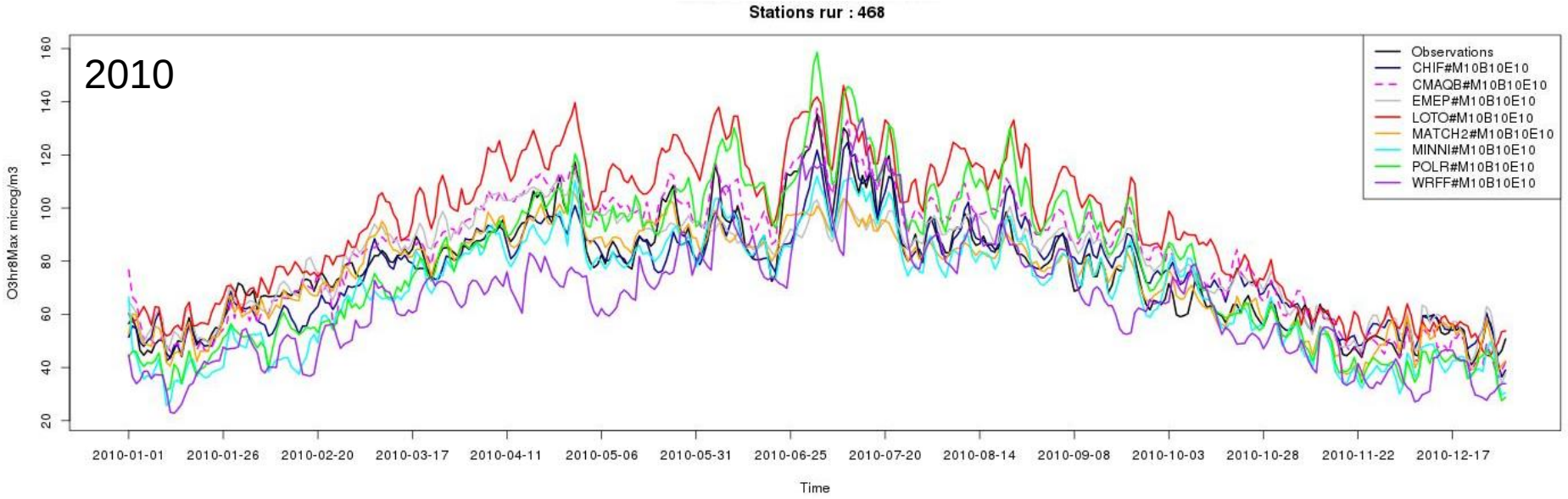
- 1990/2000/2010 reference
- Sensitivity (emissions & boundary conditions)
- Full 21yr hindcast

Ouputs

- 1.8T, 20 000 files
- Centralised on aerocom server

Tier	Scope	Contributions
1	1990/2000/2010 Reference Sensitivity to European Emissions	8
2	Sensitivity to Boundary conditions	8
3	1990-2010 trend 1990-2010 trend: with 2010 emissions	6 5

Model evaluation: Ozone (MDA8), 2010



Quite some spread amongst models ….

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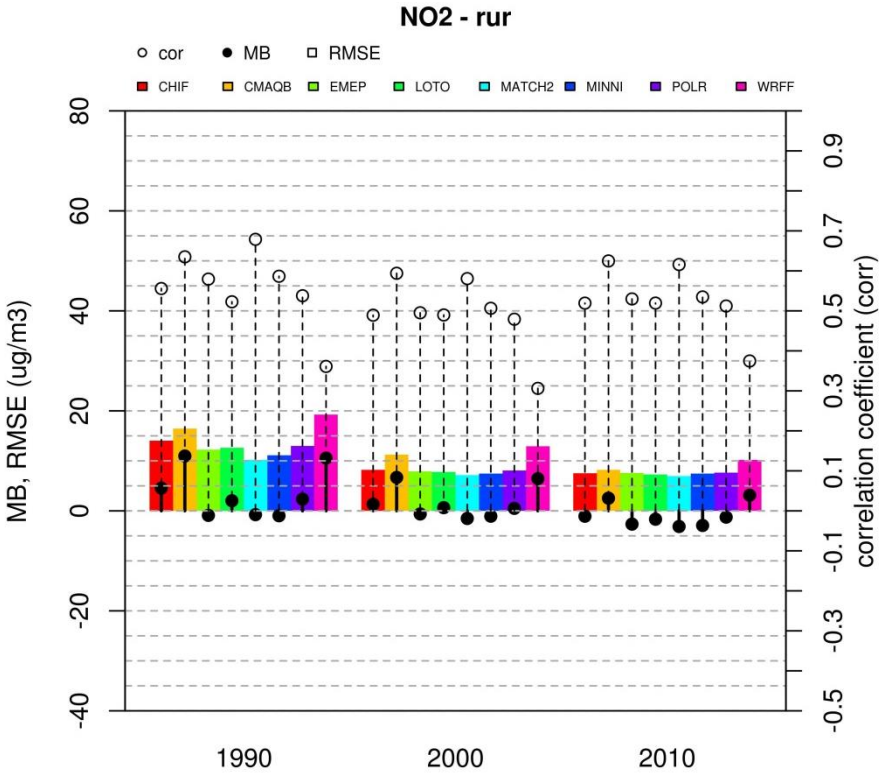
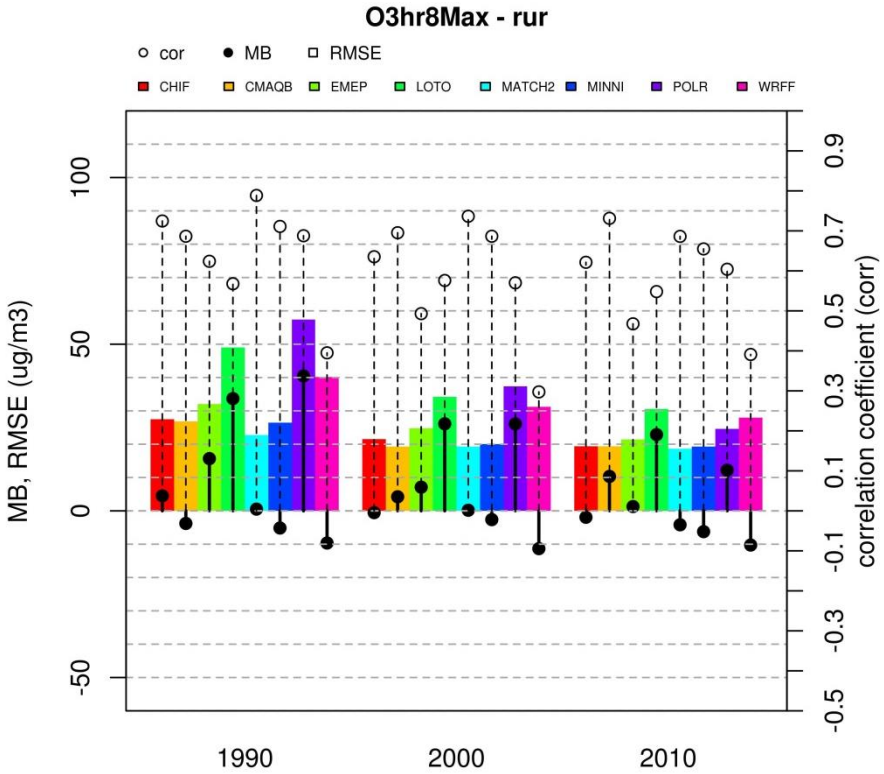
Model evaluation: NO2, O3: 1990/2000/2010

Courtesy MT Pay





But overall good performances
(although lower correlations than usual due to met driver)

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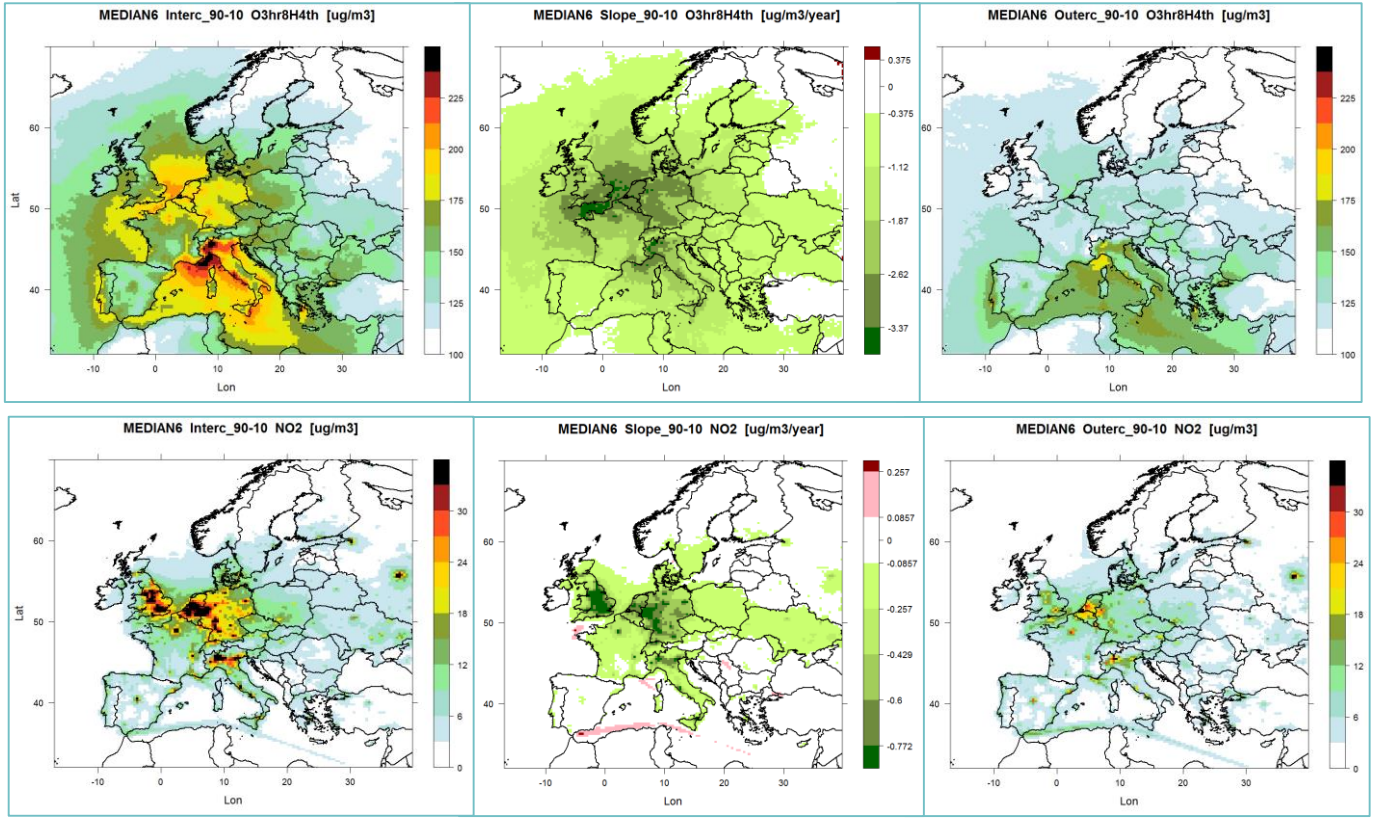
Trends: slope and estimated 1990 & 2010 levels (4MDA8, NO2)

Courtesy K. Cuvelier



MEDIAN6 (EMEP, CHIF, LOTO, MATCH2, MINNI, WRFF) – 21 years

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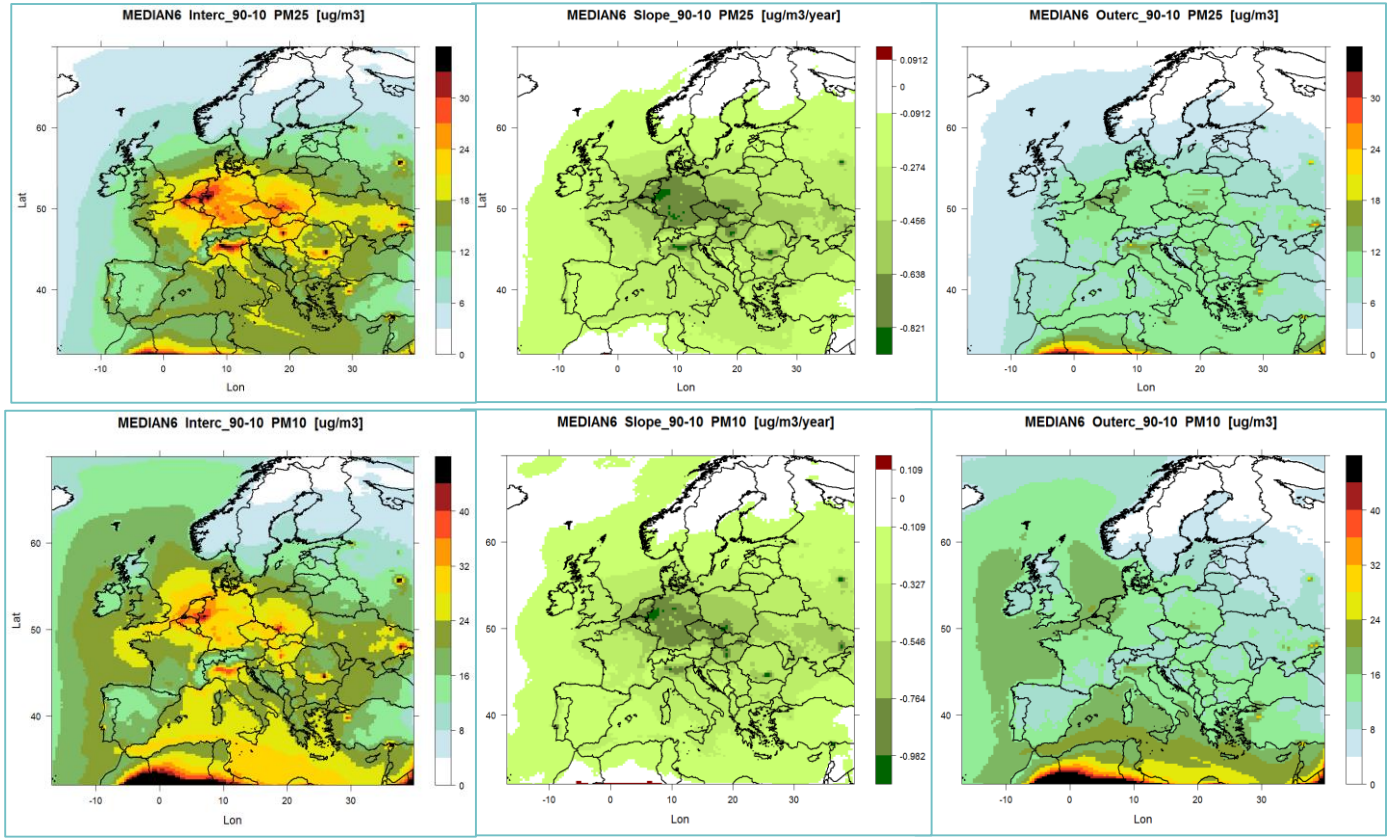
Trends: slope and estimated 1990 & 2010 levels (PM2.5, PM10)

Courtesy K. Cuvelier



MEDIAN6 (EMEP, CHIF, LOTO, MATCH2, MINNI, WRFF) – 21 years

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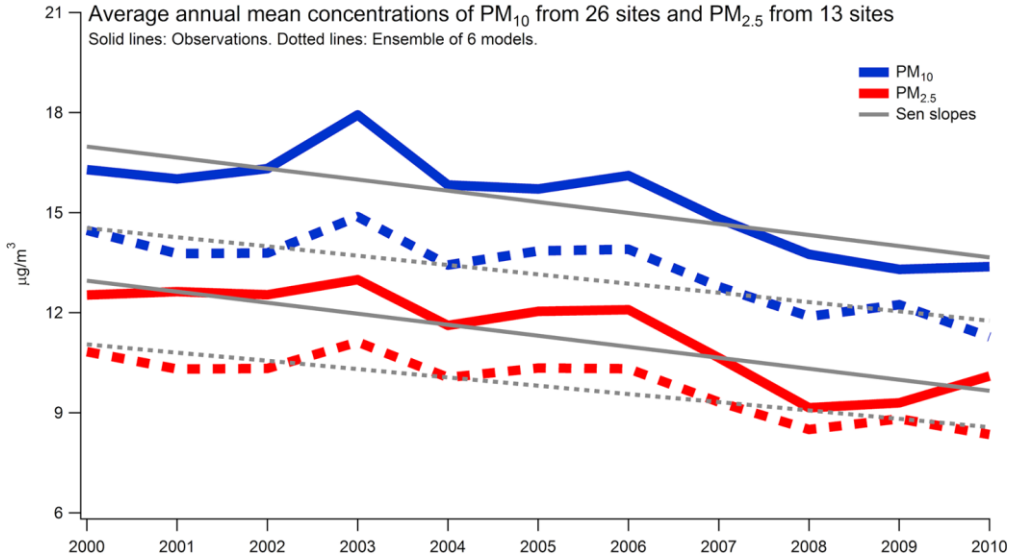
Trends: PM validation

Courtesy S. Tsyro



PM_{10} :	MOD	-0.28 µg m^{-3} yr^{-1}	-1.9 % yr^{-1}
	OBS	-0.33 µg m^{-3} yr^{-1}	-2.0 % yr^{-1}
$PM_{2.5}$:	MOD	-0.25 µg m^{-3} yr^{-1}	-2.2 % yr^{-1}
	OBS	-0.33 µg m^{-3} yr^{-1}	-2.5 % yr^{-1}

The 6-mod ensemble slightly underestimates observed trends: less for PM10 than PM2.5

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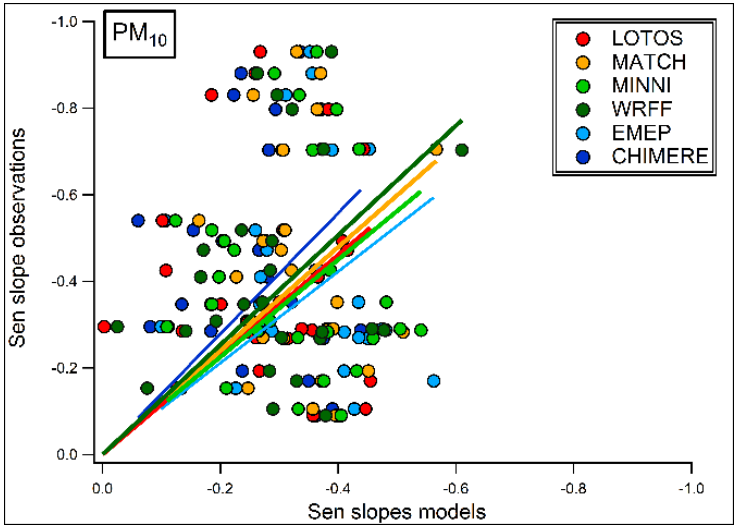
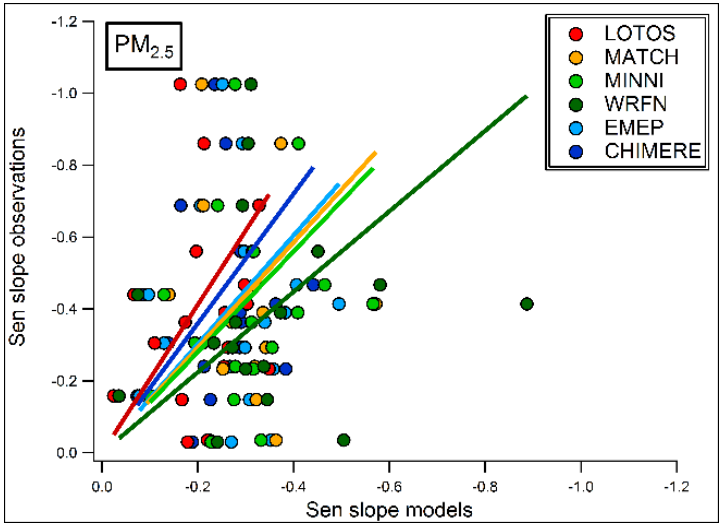
Trends: PM validation

Courtesy S. Tsyro





Large spatial variability

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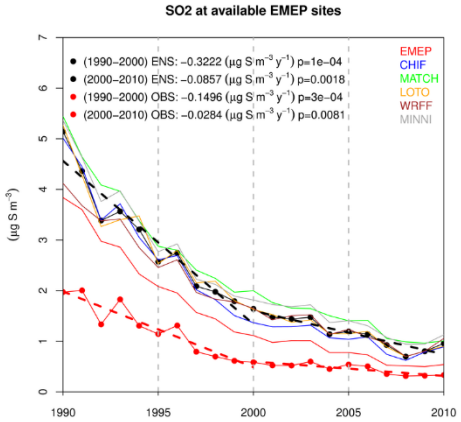
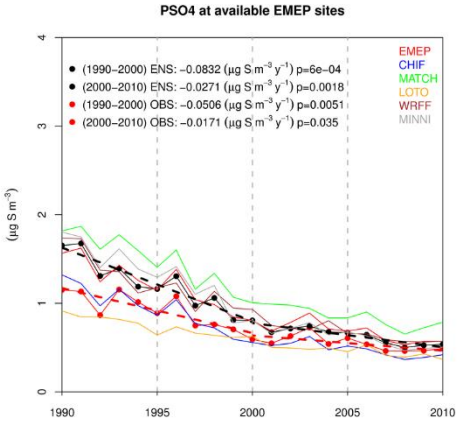
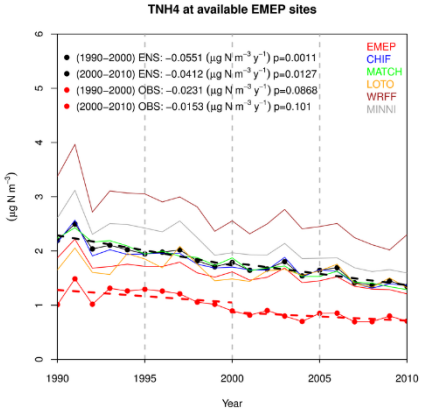
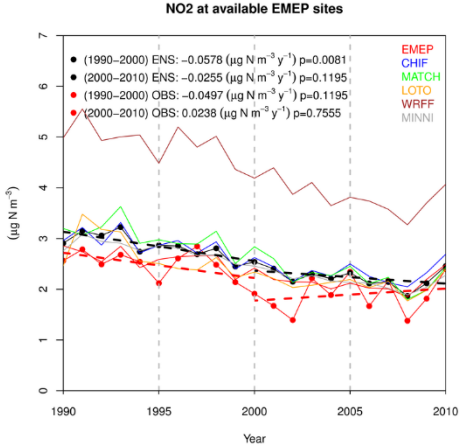
Trends: SIA validation

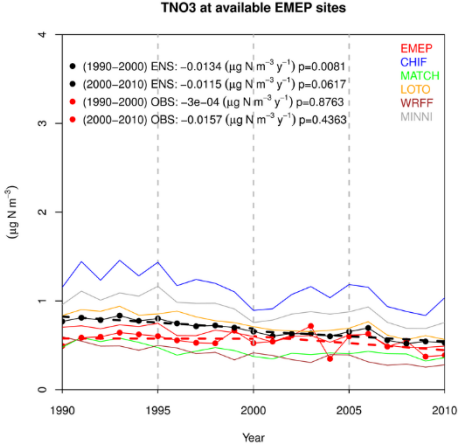
Courtesy G. Ciarelli











Overestimate SO2, but consistent trend

Capture well the flat trend for TNO3

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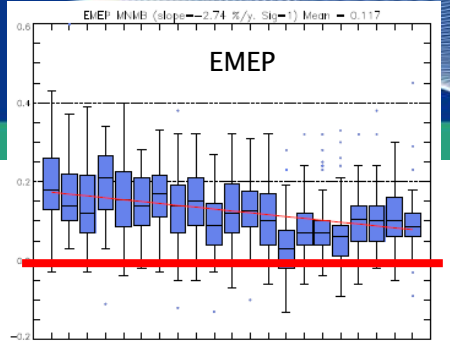
Validation of Ozone Trends

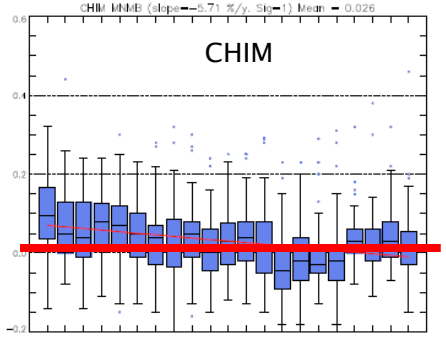
Courtesy S. Solberg

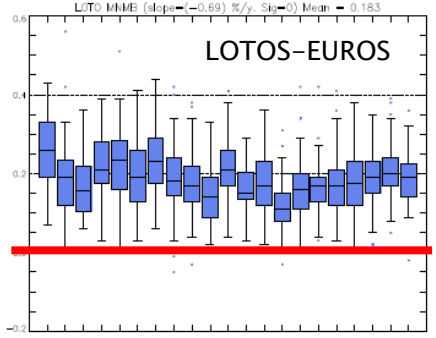
The models slightly overestimate the downward trend so that there is an improvement of model performance

Some regional differences:

- Steady performance trend in England where the strongest decline of O3 peaks was observed
- Mid and Central Europe: stronger overestimation of downward trend







MDA8
Normalized
Mean Bias

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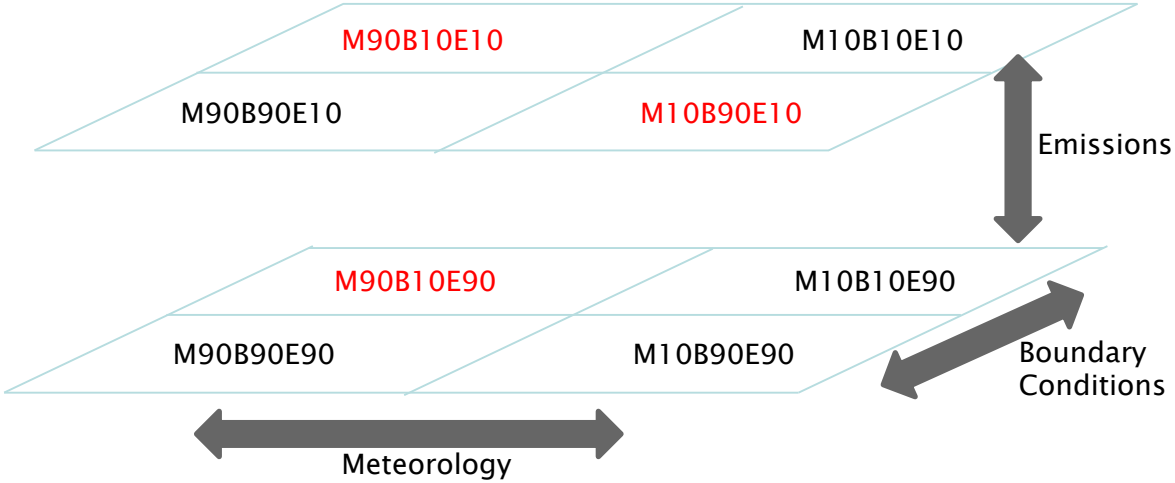
Attribution of the key driving factors

Decomposition of the main driving factors

- Emission changes
  - (M10B10E10 – M10B10E90)
- Boundary Conditions
  - (M10B10E90 – M10B90E90)
- Meteorology
  - (M10B90E90 – M90B90E90)
- Total
  - (M10B10E10 – M90B90E90)



Limitations

- Sensitivity to selected year
- Interaction terms

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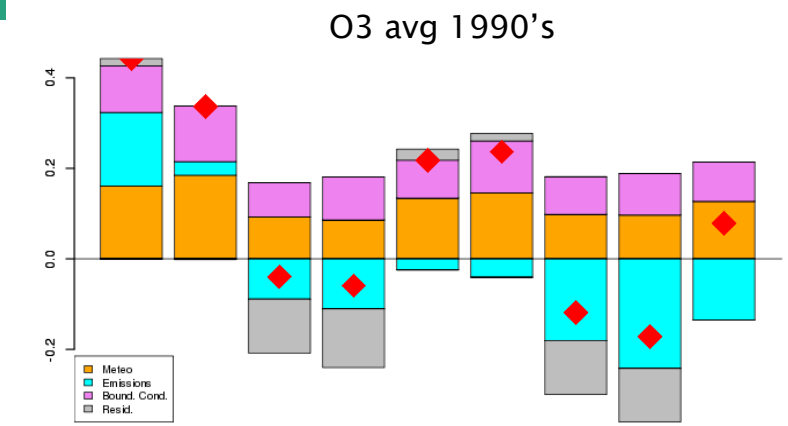
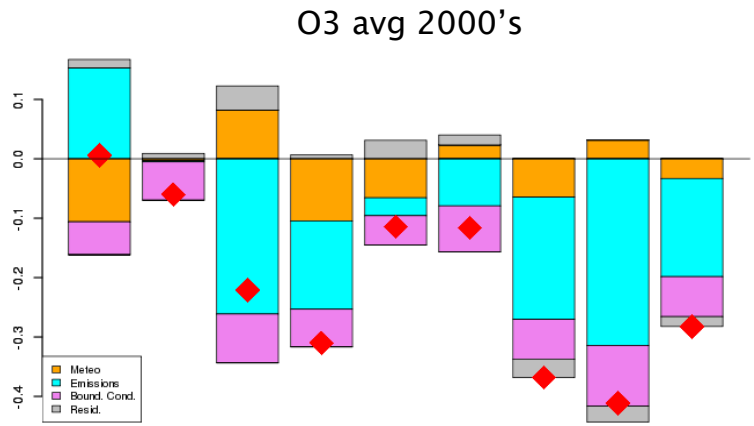
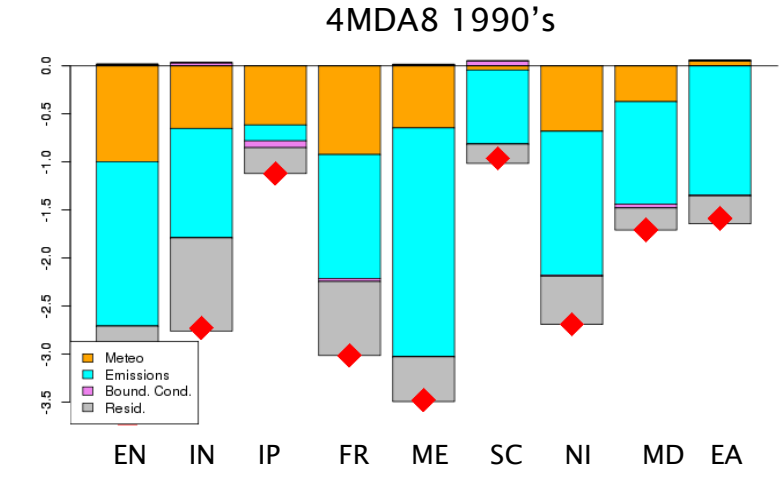
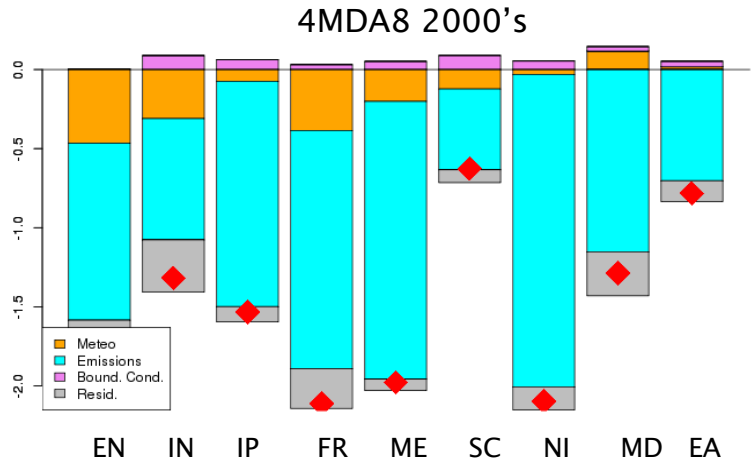
Attribution: Ozone





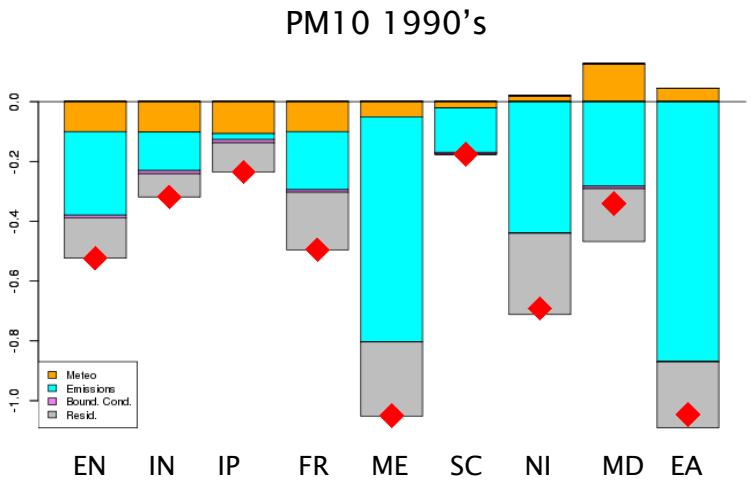


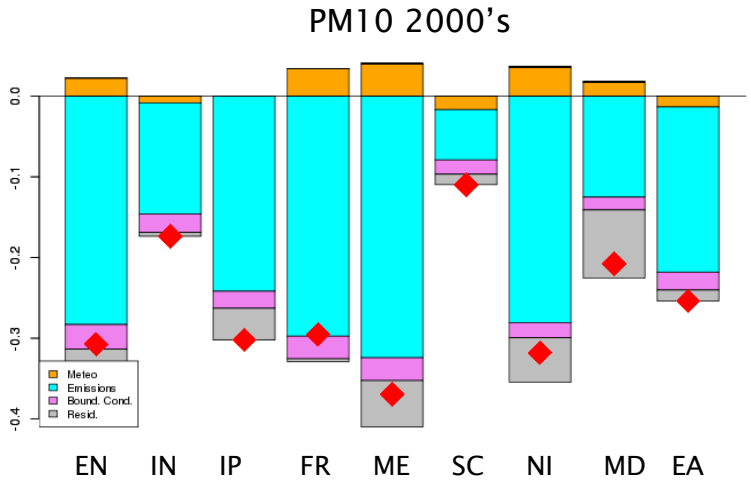


Meteo
Emissions
Bound. Cond.
Resid.

Attribution: Particulate Matter

Meteo
Emissions
Bound. Cond.
Resid.





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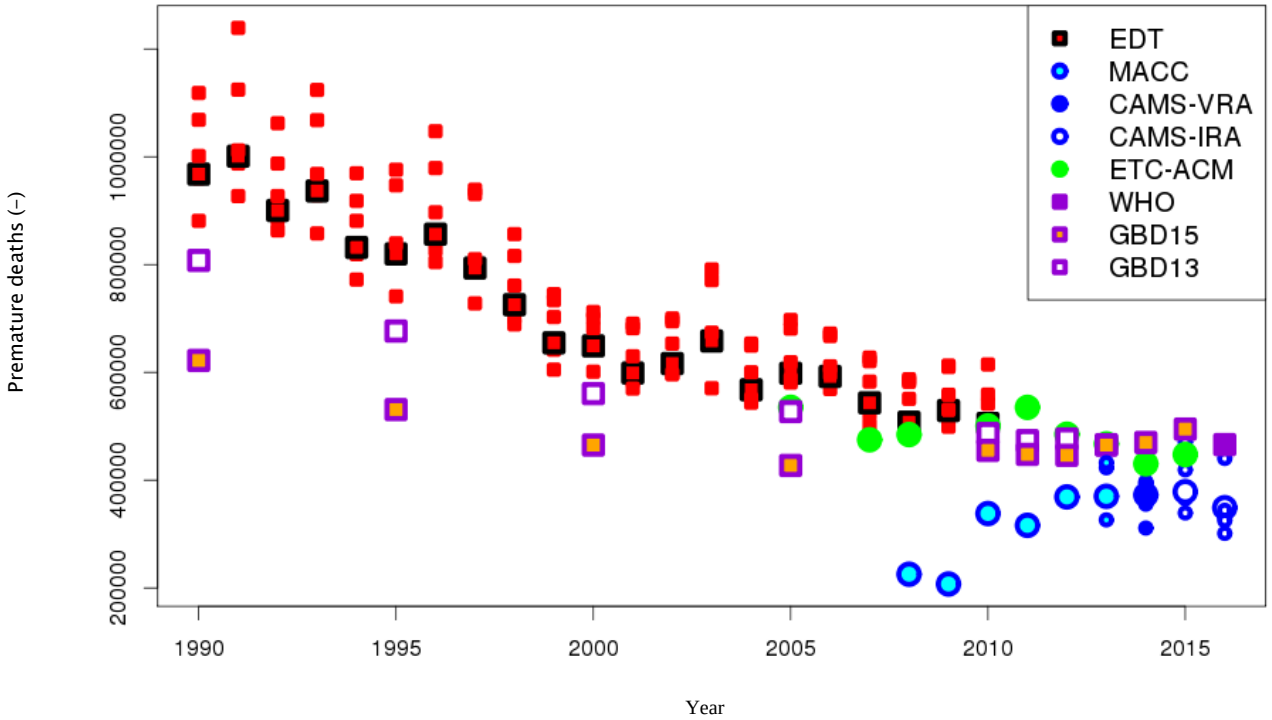
Premature deaths due to PM2.5 exposure 1990 -2016

Courtesy G. Ciarelli



About **1.000.000** deaths in **1990**
About **400.000** deaths in **2014**

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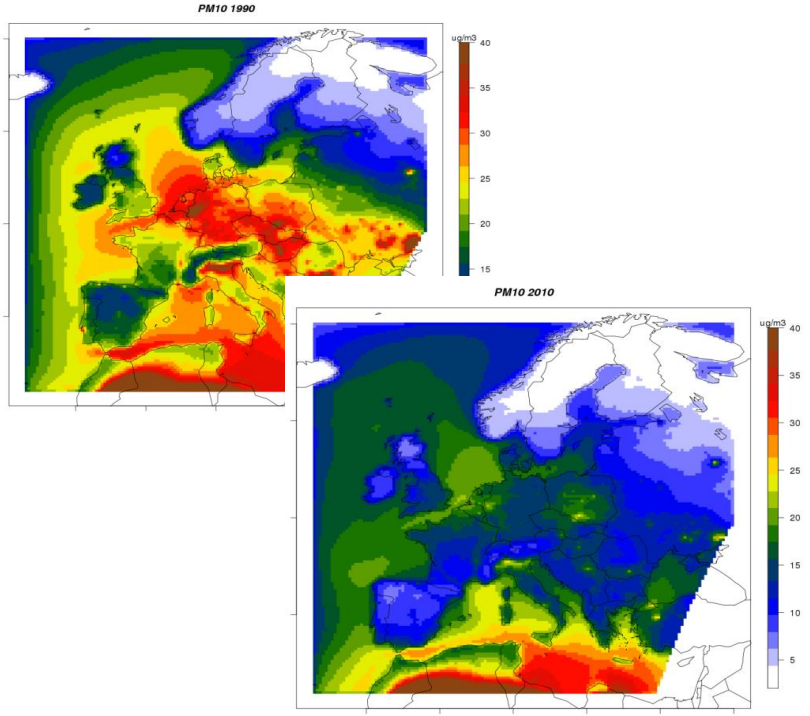
Conclusion

Main results

- Model evaluation, including capacity to capture the AQ trends
- Attribution analysis
- Impact studies

Status

- Model production completed
- 1990/2000/2010 + sensitivity
  - 8 participating CTMs
- 21 yr trend
  - 6 participating CTMs
- Model results available on aerocom database



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Thanks to the Eurodelta-Trend Modelling Team

CHIMERE (A. Colette, F. Couvidat, B. Bessagnet),
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MATCH (C. Andersson, R. Bergström),
MINNI (M. Mircea, G. Briganti, A. Cappelletti, M. Adani, M. D'Isidoro),
POLR (V. Raffort),
WRF-Chem (K.A. Mar, N. Otero, N. Ojha)